COMPUTED TOMOGRAPHIC PATTERN OF STROKE IN ADULT PATIENTS AT FEDERAL TEACHING HOSPITAL GOMBE, NORTH-EASTERN NIGERIA.

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DECLARATION

I hereby declare that this project was carried out by me during the residency training in the Department of Radiology, Federal Teaching Hospital Gombe and has not been previously submitted to any other college for consideration or for publication in any journal.

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ATTESTATION

This is to attest that this dissertation titled computed tomographic pattern of stroke in adult patients at the Federal Teaching Hospital Gombe, North-eastern Nigeria was carried out by Dr Yunusa Dahiru Mohammed under our supervision.

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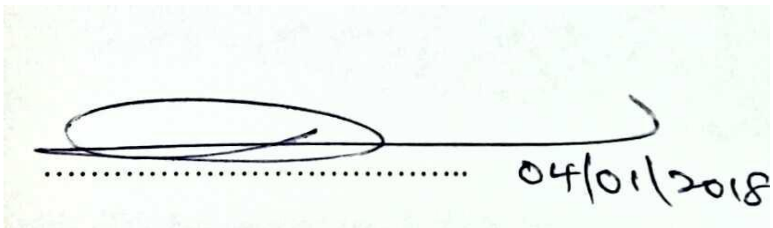
CERTIFICATION BY HEAD OF DEPARTMENT

This is to certify that this dissertation submitted to the National Postgraduate Medical College of Nigeria in partial fulfilment of the requirements for the award of Fellowship in Radiology (FMCR) was carried out by Dr. Yunusa Dahiru Mohammed during his residency training.



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DEDICATION

This dissertation is dedicated to my parents for their overwhelming support and prayers, my teachers for their valuable guidance and advice and my loving wife and children for their immense sacrifices, endurance and understanding.

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LIST OF ABBREVIATIONS

CT = Computed Tomography

HTN = Hypertension

CVA =Cerebrovascular accident

WHO = World Health Organisation

CTA = Computed Tomographic Angiography

ICH = Intracranial Haemorrhage

SAH = Subarachnoid Haemorrhage

ACA = Anterior Cerebral Artery

MCA = Middle Cerebral Artery

PCA = Posterior Cerebral Artery

CSF = Cerebrospinal Fluid

M = Mean

SD = Standard Deviation

SUMMARY

Background: Stroke and its complications are major health problems in developing countries including Nigeria. It could be a major cause of death or disability especially when only clinical assessment is relied upon for diagnosis. Cranial computed tomography (CT) is a valuable tool for the diagnosis of stroke. CT pattern of stroke in the North Eastern Nigeria has not been fully described. **Materials and Methods:** This was a prospective descriptive study conducted at the Federal Teaching Hospital, Gombe from June 2016 to December 2016. One hundred and thirty patients who presented with clinical features of stroke and were referred to Radiology department for cranial CT were consecutively selected. A total of 111 had CT scan features of acute stroke, 6 had brain atrophy, 8 had intracranial space occupying lesions and 5 were normal brain CT. Hence 111 patients with CT features of stroke were analysed using SPSS version 16.0 package. A p-value of ≤ 0.05 and a confidence interval of 95% was adapted for statistical analysis. The variables were expressed as range and mean plus standard deviation. All comparison of variables were done applying kappa statistic and point-biseral correlation coefficient for the correlation analysis. **Results:** There were 69 (62.2%) males and 42 (37.8%) females aged 18-30 years (mean ± SD of 57.49 ± 13.47 years). Ninety four patients (84.7%) had ischaemic stroke, while the remaining 17 (15.3%) had haemorrhagic stroke. Lobar location was identified as the most common site of ischaemic stroke while thalamo-ganglionic area was the commonest location for haemorrhagic stroke. This study found a discordance between clinical and CT diagnosis of stroke kappa = 0.289. Age and hypertension were found to be the commonest risk factors associated with both ischaemic and haemorrhagic stroke. **Conclusion** It is evident from this study that clinical diagnosis of stroke subtypes may not be reliable without neuroimaging, further justifying the need for CT scan in the proper evaluation of stroke patients. The middle cerebral artery territory was the commonest vascular territory involved in stroke while hypertension and age are common risk factors for both ischaemic and haemorrhagic stroke.

Keywords: stroke, cranial, CT scan, Nigeria, North-east

INTRODUCTION

Cerebro-vascular accident (CVA) or stroke occurs when the blood supply to the brain is disturbed in some ways. As a result, brain cells are starved of oxygen causing some cells to die and leaving others damaged. Stroke can be defined as a focal neurological deficit of vascular origin lasting more than 24 hours and is often preceded by transient ischaemic attack in 10 – 15% of cases.[1] According to World Health Organization (WHO), stroke or CVA has been defined as a syndrome of rapidly developing clinical symptoms and signs of focal or global loss of cerebral functions lasting 24 hours or longer or resulting in the individual demise traceable only to vascular pathology.[2,3] Stroke can also be defined as rapidly developing loss of brain functions due to a disturbance in the blood vessels supplying blood to the brain. This can be due to ischemia caused by thrombosis or embolism or due to a haemorrhage.[4] In the past, stroke was referred to as cerebro-vascular accident or CVA, but the term "stroke" is now preferred. A stroke is a medical emergency and can cause permanent neurological damage, complications and death. It is the leading cause of adult disability in the United States and Europe and the second cause of death worldwide.[5]

In Southeast Asia and Africa, where peak age of the disease is 1 to 2 decades earlier than in industrialized countries and accounting for 0.9% - 4% of hospital admissions, a significantly higher proportion of stroke is haemorrhagic.[6] In industrialised countries the prevalence of stroke is much higher in males than females with a ratio of 5:3, however this reverses after the age of 85yrs with higher prevalence in females than males.[6]

The current prevalence of stroke in Nigeria is 1.14 per 1000 while the 30-day case fatality rate is as high as 40%.[7] The factors that determine outcome following stroke include the stroke subtype, patient bio-profile (age, gender), disease severity, physiological parameters (blood pressure on admission, blood glucose, level of consciousness), and presence of complication.[8,9,10]

There are two major types of stroke; ischaemic and haemorrhagic with the Ischemic stroke accounting for the majority of cases (80%) globally.[1] The onset of symptoms may be sudden, especially in the haemorrhagic type or gradual in the ischemic type.[1] However, the features are similar in both types, but the neurological deficits vary according to the location and severity of the bleed or infarct. With advances in technology, imaging has become integral for the evaluation and management of acute stroke patients.[11,12,13] A non-enhanced computed tomography (CT) scan has been shown to be the first imaging tool for diagnosis of cerebral haemorrhage and infarcts and to rule out other brain lesions that may mimic stroke, such as, tumours, extradural hematomas and abscesses.[14] In addition CT is the most suitable for critically ill patient, it is fast, relatively available and have fewer restriction when compared to MRI.

Computed tomography angiography (CTA), with or without perfusion studies, rapidly provides visualization of the blood flow and vascular occlusions, as well as assesses for salvageable brain tissue.[14,15]

The purpose of the study was to evaluate the CT pattern of stroke in adult patients in Federal Teaching Hospital Gombe.

AIM AND OBJECTIVES

Aim

To determine the pattern of CT findings of stroke in adult patients in Federal Teaching Hospital Gombe, North-Eastern Nigeria.

Objectives

- To determine the relative proportion of stroke subtypes and involved vascular territories among study subjects.
- To compare clinically suspected stroke subtype with CT subtype.
- To determine associations between stroke risk factors and specific stroke subtypes.

HYPOTHESIS AND SUBHYPOTHESES OF THE STUDY

HYPOTHESIS

The CT findings in stroke are related to the stroke subtype

SUB HYPOTHESES

- There is no significant difference in the prevalence of ischaemic stroke and haemorrhagic stroke.
- There is no significant difference in the prevalence of middle cerebral artery stroke and other vascular territories.
- The clinical diagnosis of stroke subtypes does not differ with CT findings.

JUSTIFICATION

Stroke is a frequent cause of death and disability and is a major health problem in most parts of the world. It causes approximately 200,000 deaths each year in the United States making it the third most common cause of death in the United States and trailing only heart disease and cancer.[16] In Africa, stroke accounts for 0.9% to 4% of all hospital admissions, and 2.8% to 4.5% of total deaths.[17] The incidence of stroke in Africa is on the increase.[18,19,20 & 21] In Nigeria the current prevalence of stroke is 1.14 per 1000 while the 30-day case fatality rate is as high as 40%.[7]

With all these aforementioned morbidity and mortality of stroke, clinicians usually rely on clinical evaluation in the diagnosis and in classifying stroke into its subtypes, using WHO criteria or the Siriraj Stroke Score .[22,23 24] However, the sensitivity and specificity of both scores are as low as 35‑63%, according to validation studies using brain CT scans as the gold standard.[25,26] Furthermore, stroke scores do not exclude cerebral abscesses or tumours mimicking stroke; and they also do not distinguish subarachnoid haemorrhage (SAH) from intracerebral haemorrhage (ICH).[27]

In comparison to other geopolitical zones in the country, there is paucity of data on CT assessment of stroke patients in North-eastern Nigeria. The aim of this study was to evaluate the pattern of common CT findings in patients with stroke in this locality in order to provide the baseline data that will enable accurate diagnosis in patients affected by stroke.

ANATOMY

The Brain is one of the component of the central nervous system, it consist of the cerebrum, cerebellum and brainstem. The cerebrum is made up of two cerebral hemispheres with each hemisphere consisting of cortical grey matter, white matter, basal ganglia, thalamus, hypothalamus, pituitary gland and the limbic lobe. The cerebral hemispheres are separated by the cerebral falx within the longitudinal cerebral fissure. Each cerebral hemisphere is divided in to four lobes; frontal, parietal, temporal and occipital lobes. The brain stem is made up of mid brain, pons and medulla oblongata. The medulla, pons, and cerebellum together constitute the hindbrain.

Within the brain are a number of cavities: the lateral, third and fourth cerebral ventricles, which contain CSF produced by the choroid plexuses within the ventricles. Cerebro spinal fluid flows from the ventricles into the subarachnoid spaces over the cerebral surface and around the spinal cord. Blood reaches the brain by the carotid and vertebral arteries and is drained by cerebral veins into a series of sinuses within the dura into the internal jugular veins.

Radiological anatomy

On CT the electron density of grey matter is slightly higher than that of the white, and adequate images allow clear differentiation of the larger grey and white matter areas of cerebral hemispheres and cerebellum. The superolateral surface of each cerebral hemisphere has two deep sulci; this includes: the lateral sulcus**,** also known as the sylvian fissure, which separates the frontal and temporal lobes and the central sulcus (of Rolando), which passes upwards from the lateral sulcus to the superior border of the hemisphere which separates the frontal and parietal lobes.

On axial section the head of the caudate nucleus is seen projecting into the anterior horn of the lateral ventricle on slices taken at ventricular level**.** The head of the caudate nucleus is usually more radiodense than the lentiform nucleus or the thalamus, especially in older subjects. The body of the caudate nucleus is seen as a thin, dense stripe on the superolateral margin of the lateral ventricle on higher cuts, where it should not be confused with heterotopic cortical tissue. The claustrum is a high-attenuation stripe, separated from the putamen by the external capsule and from the insula by the external capsule. The lentiform nucleus is lens shaped and is made up of a larger lateral putamen and a smaller medial globus pallidus. Medially, it is separated from the head of the caudate nucleus anteriorly, and from the thalamus posteriorly by the internal capsule. A thin layer of white matter on its lateral surface is called the external capsule.

The thalamus is a pair of ovoid bodies of grey matter lying on the lateral walls of the third ventricle extending from the interventricular foramen anteriorly to the brainstem posteriorly. Each has its apex anteriorly and a more rounded posterior end called the pulvinar. The thalamus is related laterally to the internal capsule and, beyond that, to the lentiform nucleus. The body and tail of the caudate nucleus are in contact with the lateral margin of the thalamus. The superior part of the thalamus forms part of the floor of the lateral ventricle.

The internal capsule is a V-shaped low-attenuation between the caudate and lentiform nuclei anteriorly and the lentiform and thalamus posteriorly. The corpus callosum is a large midline mass of commissural fibres, each of which connects corresponding areas of both hemispheres which is best seen on a mid sagittal section. The midbrain is visualised on axial CT at the level of the circle of Willis**.** The crura are identified anteriorly and the colliculi posteriorly. It is not always possible to identify the cerebral aqueduct. The pons is easily identified by the bulbous appearance of its anterior part and the cerebellopontine fibres of the middle cerebellar peduncle is seen as an area of low attenuation extending from the pons into each cerebellar hemisphere. The upper medulla is identified easily by the presence of the fourth ventricle and cerebellum posteriorly.

On axial CT sections taken through the pons, the cerebellum is separated from the pons by the fourth ventricle and connected to the pons on each side of this by the middle cerebellar peduncles. At this level the cerebellum is bounded anteriorly by the petrous temporal bones. On higher sections the cerebellum is separated from the temporal and occipital lobes anterolaterally by the tentorial margins. Close to its bony attachment the tentorium is easily seen on contrast-enhanced studies owing to the contained superior petrosal sinus.

The ventricular system are hypodense CSF-filled spaces. On axial images, starting on the lowest cuts, the fourth ventricle appears as a slit-like structure between the brainstem and the cerebellum. Sections taken through the midbrain may show the aqueduct with high-attenuation periaqueductal grey matter. The third ventricle becomes visible on higher cuts as a slit-like structure between the thalami. The temporal horns of the lateral ventricles are small or not visible unless they are dilated. Higher cuts show the bodies of the lateral ventricles separated by the septum pellucidum or by the corpus callosum.

In post contrast images, the circle of Willis and its branches are visualised in the suprasella cistern. The anterior cerebral artery (ACA) and its branches are seen within the interhemispheric fissure while branches of the middle cerebral artery (MCA) may be identified in the sylvian fissure as tubular hyperdensities of seen end-on as rounded hyperdensities. The posterior cerebral arteries or the posterior mesencephalic veins may be seen passing round the midbrain as hyperdense tubular structure while the basilar artery is seen anterior to the pons in the midline, or slightly on either side of the midline as rounded hyperdensity.

CT FINDINGS IN ISCHAEMIC STROKE

Noncontrast CT

CT can detect the effects of ischemia on brain tissue. Ischemia is a functional state of abnormal blood flow that initially leads to neuronal and endothelial cytotoxic oedema and subsequently, to vasogenic edema.[28] This increase in the water content of the brain causes X-ray attenuation and is seen as a hypodensity on CT.

- Early findings (within 6 hours) include subtle loss of gray-white matter differentiation corresponding to increased water content from early cytotoxic oedema.[29,30] Loss of definition with obscuration of the cortical and deep gray matter structures may be visible.
- In middle cerebral artery(MCA) infarction, the obscuration of lateral margins of the insula (the insular ribbon sign) and loss of density of the basal ganglia nuclei, such as the lentiform nucleus (vanishing basal ganglia sign) may occur. [31, 32]
- Hyperattenuation of vessels may be seen (dense vessel sign or dot sign); these are believed to represent acute thrombus or embolus and has been described in the MCA, basilar artery, and venous sinuses. [33, 34] When found in the proximal MCA it correlates with large infarcts, although it has a better prognosis if limited to an MCA branch within the Sylvian fissure.[35] Middle cerebral artery calcification can mimic this sign but is often

bilateral. The basilar artery may also appear dense in the case of posterior circulation infarcts particularly the ‘top of basilar’ syndrome.

- After approximately 12-24 hours, a well-defined area of hypodensity, which may have associated mass effect with sulcal or ventricular effacement, may be seen. The hypodensity is usually irreversible and is found to correlate with minimum final infarct size.[36,37]

- Mass effect typically peaks by about 5 days post ictus and disappears over the next several weeks.[37]

In roughly one half of cases, the infarct may change from hypodense to isodense. This has been termed the "fogging effect" on CT and is usually seen 2-3 weeks post ictus during the subacute phase of infarction and should resolve on subsequent imaging. The administration of intravenous contrast may make the infarct more conspicuous and this is believed to be due to influx of lipid-laden macrophages, decreased water content, proliferation of capillaries, reperfusion and petechial hemorrhage.[38, 39]

After approximately 6-8 weeks, a well-defined cavity may develop, corresponding to encephalomalacia. Evidence of volume loss such as ex-vacuo dilatation of the adjacent ventricle may present. Cortical laminar necrosis may be seen in chronic infarcts with gyriform cortical calcification.

Lacunar infarcts appear as small (5-15 mm) areas of low density initially and after approximately 4 weeks may appear as well-defined cystic low-density areas. Typical locations include the subinsular regions, basal ganglia, thalami, capsular regions and corona radiata.

Contrast-enhanced CT

Contrast enhancement following brain infarction is typically seen in about two thirds of cases, usually during the second or third week post ictus. Common patterns of enhancement include patchy, gyriform, ring-like and homogenous enhancements. Early contrast enhancement noticed with infarcts with large volume and associated mass effect is secondary to disruption of the blood-brain barrier causing increased vascular permeability and/or reperfusion from recanalization or collateral circulation. Early contrast enhancement therefore portends an increased risk of haemorrhagic transformation.

Some of the cranial CT will show normal scan findings in patients with clinically diagnosed stroke. Even with state-of-the-art 3rd and 4th generation scanners, most ischemic strokes will go undetected for the first few hours. Hence, the "Normal CT Scan" is perfectly compatible with acute ischemic stroke.[40, 41]

CT FINDINGS IN HAEMORRHAGIC STROKE

Non contrast enhanced CT is the imaging modality of choice in the diagnosis of acute intracerebral hemorrhage. The appearance of intracranial hemorrhage on CT is comparatively straightforward. There is a linear relationship between CT attenuation and haematocrit, haemoglobin concentration and protein content. The haematocrit of an acute retracted clot is around 90% and the globin (protein) component of haemoglobin has a high mass density, fresh intracerebral blood clots typically appear hyperdense (60 to 80 HU) on CT when compared to normal brain.[42] [43] The attenuation of intracerebral hematomas decreases with time, diminishing at an average of 1.5 HU per day.[44]

Haemorrhagic stroke can be broadly divided into four categories;

1. Lobar haemorrhage; it is seen as hypderdense collection of blood, located superficially within the lobes of the brain other than the basal ganglia. It is a subtype of intracranial haemorrhage, which generally carries a poor prognosis.

2. Hypertensive haemorrhage; hypertension is the most common cause of intracerebral haemorrhages. They can be conveniently divided according to their typical locations which include in order of frequency: basal ganglia haemorrhage (especially the putamen), thalamic haemorrhage, pontine haemorrhage and cerebellar haemorrhage

3. Secondary haemorrhages: some intracerebral haemorrhages eventually are shown to be haemorrhage from an underlying lesion, e.g. vascular malformation.

4. Subarachnoid haemorrhage.

LITERATURE REVIEW

Stroke or CVA has been defined as a syndrome of rapidly developing clinical symptoms and signs of focal (or global) loss of cerebral functions, with symptoms lasting 24 hours or longer or resulting in death with no apparent cause other than of vascular origin.[2,3] A stroke or CVA is defined by this abrupt onset of a neurologic deficit that is attributable to a focal vascular cause. Thus, the definition of stroke is clinical and laboratory studies including brain imaging are used to support the diagnosis.

Globally, about 16 million new cases of stroke and 62 million stroke survivors were documented in 2005, with deaths from stroke accounting for 9.7% of all global deaths, and this is expected to increase to over 23 million new stroke cases and 7.8 million stroke deaths by 2030 in the absence of significant global public health response.[45] Stroke causes approximately 200,000 deaths each year in the United States making it the third most common cause of death in the United States, accounting for approximating 7% of all death.[15] The incidence of cerebrovascular diseases increases with age, and the number of strokes is projected to increase as the elderly population grows, with a doubling in stroke deaths in the United States by 2030.[16]

Africa is particularly worst hit, owing to population growth, unchecked industrialization and increased consumption of western diets, leading to a rise in many modifiable vascular disease risk factors including smoking, harmful use of alcohol, physical inactivity and unhealthy diets, and invariably resulting in increased prevalence of hypertension, diabetes and obesity.[46, 47] Stroke is commoner in males, approximately for every 3 female stroke patients there are 5 to 4 males up to the age of 85yrs (in industrialised countries). However beyond this age the number of females with stroke predominate. [6]

The current prevalence of stroke in Nigeria is 1.14 per 1000 while the 30-day case fatality rate is as high as 40%.[7] The factors that determine outcome following stroke include the stroke subtype, patient age, gender, disease severity, physiological parameters (blood pressure on admission, blood glucose, level of consciousness), and presence of complication.[8,9,10] Stroke accounts for 0.9 - 4% of medical admissions and 0.5 - 45% of neurological admissions in Nigeria.[48,49]

Ischemic stroke is the commonest among the stroke subtypes, accounting for the majority of cases (80%) globally.[1] Adeyakun *et al* reported the incidence of ischemic stroke as 73.8% of all patients with stroke in Nigerians.[50] Similarly a study conducted in South-Eastern Nigeria by Eze *et al*[11] demonstrated higher incidence of ischaemic stroke than haemorrhagic, 57% versus 23% respectively. In the same study stroke was found to be significantly higher in males 73% than in females 23%. Similarly higher incidence of ischaemic stroke was found in studies conducted by Chhetri *et al*[51] and Kehinde *et al*[52] .

On the contrary, Obiako *et al*[53] studied adult patients who presented to the medical emergency unit of University College Hospital (U.C.H), Ibadan in coma from acute stroke. They highlighted that in this group of stroke patients, intracerebral hemorrhage was more frequent (78.8%) while large cerebral infarction accounted for 21.2%.

Luntsi *et al*[54] in their study also documented higher incidence of stroke in males with a male: female ratio of 1.7:1. However Lloyd *et al*[55] have shown in a research conducted in USA that, the incidence of stroke in women exceeds that in men at older ages. Women 45-54 years are reported to be more than twice as likely as men to suffer a stroke.

Numerous studies have demonstrated that the age-specific incidence of stroke increases with each decade of life. Stroke is a disease of increasing importance in the elderly population, with approximately 75% of strokes occurring in those older than 65 years.[3938] Ukoha *et al*[56] in a study conducted in a Nigerian military hospital reported the ages of patients presenting with stroke ranged from 30yrs to 79yrs with stroke occurring highest among persons between 60 – 69yrs.

Similarly 53 stroke patients were studied in Maiduguri, North-Eastern Nigeria by Bwala,[57] and he found that the mean age of presentation of stroke was 55 years, with male: female ratio of 2**.**5**:** 1. He also found that 63% of the patients had ischaemic stroke while 37% had haemorrhagic stroke. In another study conducted in Senegal by Sagui *et al,*[58] it was reported that haemorrhagic stroke is more in younger age with a mean age of 51 years than ischaemic stroke which has a mean age of 64.2 years.

Saad *et al*[59] reported that, carotid territory were involved in 66.9% of the 174 stroke patients they studied, while the vertebro-basilar territory was involved in 28.5%. In the same study haemorrhagic stroke was found to be more frequently located in the basal ganglia including thalamus accounting for about 76% of all haemorrhagic stroke, while 21% were lobar in location. Subarachnoid haemorrhage was reported as rare (2.4%) among the 107 patients studied.

Ikpeme *et al*[60] reported that stroke (both ischaemic and haemorrhagic) predominantly occur in the left cerebral hemisphere accounting for about 53% with the right cerebral hemisphere accounting for 40%. In 6.6% the lesions were bilateral. In the same study the parietal lobe was the most frequently involved location of stroke while lentiform nucleus was the second most common location.

Oyinloye *et al* [61] studied stroke in young adults. They reported a total of 21 (35%) out of the 60 cases confirmed on imaging had intracerebral hemorrhage (ICH), 10 (16.7%) subarachnoid hemorrhage (SAH) and 29 (48.3%) had cerebral infarct (CI). Hypertension was the common risk factor for all the stroke subtypes. The most common location for ICH was the basal ganglia in 8 (38.8%), while the commonest pattern for CI was lacunar infarct in the basal ganglia (51.7%).

Chhetri *et al*[52] also found ischaemic stroke to have higher frequency than haemorrhagic stroke, and among the ischaemic subtypes MCA was involved in 75%. The PCA was involved in approximately 15% and ACA in 10% of cases. Hence, they concluded that most stroke occur in supratentorial region (90%) and the posterior fossa was involved in 10% of cases. The same study highlighted that in both ischaemic and haemorrhagic stroke, internal capsule and basal ganglia were the commonest region involved followed by the tempero-parietal cortex.

In another study conducted by Ogunseyinde *et al*[62] in Ibadan, they reported ischaemic stroke (55%) predominating haemorrhagic stroke (43%). They further reported that stroke occurred more in the left hemisphere and significantly more on the left when it is haemorrhagic.

Similarly Chiewvit *et al*[63] studied 131 haemorrhagic stroke patients and found 61% had intracerebral haemorrhage, 22% had SAH and the least was interventricular haemorrhage (3%). In terms of location, they found the most common site was thalamus and basal ganglia accounting for about 41% while other locations were lobar, cerebellum and brain stem.

Recent risk factor analysis for stroke conducted by Amu *et al*[64] revealed hypertension as the most common risk factor reported in 82.5% of patients with stroke. In many other studies diabetes mellitus has been reported in up to 20-37% of patients with stroke. Similar findings was seen in a study conducted by Sanya *et al*[65] where they found the prevalence of stroke to be higher among the males than females and 94% of stroke patients had one or more associated risk factor. Uncontrolled systemic hypertension (82.4%) was the most common risk factor identified in their study followed by previous history of TIA (41.2%), while smoking and excessive consumption of alcohol were seen in 17.6% and 11.8% respectively. These risk factors were also associated with diabetes mellitus.

Ukoha *et al*[56] study of stroke risk factors revealed systemic hypertension as the commonest risk factors. They documented that, deranged lipid profile and diabetes mellitus were seen in 46% and 24% respectively. Watila *et al*[66] in their study conducted in Maiduguri, North-Eastern Nigeria also recorded high incidence of ischaemic stroke (62%), while haemorrhagic stroke accounted for 32% and SAH was the least at 1.2%. They also highlighted that the most frequent risk factors were hypertension 87%, past history of stroke 11.5%, diabetes mellitus 10.1%, alcohol consumption 8.8%, smoking 6.8%, TIA 5.3% and heart failure 2.4% while 19,7% of their study population had more than one risk factors.

Abubakar *et* al[67] in a study conducted in Sokoto indicated that, systemic hypertension as a risk factor was associated with ischaemic stroke in 51% of cases and was found to be more associated with haemorrhagic stroke (62%). Diabetes mellitus was associated with 48% of ischaemic stroke, while it was less frequent in haemorrhagic stroke 8%. They also found that almost all patients with previous history of TIA had ischaemic stroke and constituted 13% of total patients with stroke. However Chiewvit *et al*[48] found 25% of their studied patients had no associated risk factors while the remaining 75% were known to have systemic hypertension.

In another study conducted by Alkali *et al*[68], in which 272 stroke patients were reviewed, 61.8% had cerebral infarction, 34.7% had ICH, and 3.4% had SAH. In those with ICH, lobar hemorrhage was most common (35.1%), followed by bleeding at the basal ganglia (28.7%), thalami (18.1%), pons (9.6%), cerebellum (5.3%) and midbrain (2.1%).

Ogun *et al*[69] highlighted the need for neuroimaging especially cranial CT in patients with stroke, as the clinical diagnosis demonstrated only 50% accuracy in diagnosing haemorrhagic stroke and 58% in diagnosing ischaemic stroke when compared with the CT findings of the same patients. Similarly in a prospective study conducted by Jehangir *et al*[70], where they compared clinical diagnosis with CT findings in ascertaining stroke subtypes, they reported that out of 25 clinically suspected haemorrhagic stroke only 13 had haemorrhage on CT scan showing 52% accuracy of clinical diagnosis, while the rest 12 (48%) had infarction. In the same study out of the 43 clinically suspected ischaemic stroke only 25 proved to have infarction on CT scan reflecting a clinical accuracy of 58.6%.

MATERIALS AND METHOD

Study design: This is a prospective descriptive study conducted at the Federal Teaching Hospital Gombe between June 2016 and December 2016. Subjects were recruited consecutively based on the inclusion criteria stated below.

Study area: The study was carried out at the Federal Teaching Hospital (FTH) Gombe, the capital of Gombe State, located in the North-Eastern part of Nigeria. The State shares common borders with Borno, Yobe, Taraba, Adamawa and Bauchi States and has a land area of about 20,265 km^2 and a population of about 2,353,000 people based on 2006 census figure. Gombe lies on the geographic coordinates of 10º 17' 21''N, 11º 10' 18''E and has two distinct climates, the dry season (November–March) and the rainy season (April–October) with an average rainfall of 850mm and a largely Sudan savannah vegetation.

The State is inhabited by many tribes which include Fulani, Hausa, Tangale, Tera among others. Hausa is the most commonly spoken language among the inhabitants. The people of Gombe state are primarily farmers, livestock breeders and traders. Industries in the state include the Ashaka Cement Company and other small scale industries. The predominant religion is Islam with a sizable population of Christians.

Sampling Technique

The patients were recruited using continuous consecutive sampling technique using the inclusion criteria below.

Sample size determination:

The required sample size was calculated using the Fisher's formula

$$N = Z^2 pq / d^2$$

N = minimal sample size required

Z= standard normal variant, which at 95% confidence interval = 1.96

P=prevalence of cerebral infarction on brain CT according to Watila *et al*[66] **p**= 63%

q=1-**p**=1-0.63=0.37

d=desired precision=10%

Therefore;

$$N = 1.96^2 \times 0.63 \times 0.37 / 0.1^2$$

N=89

However, 20% attrition factor was added and a sample size of 130 was used to increase the sensitivity of the study.

Study population: The study population consisted of 130 adult stroke patients who were referred from the Accident and Emergency Unit or Medical Ward to Radiology Department, Federal Teaching Hospital Gombe, for cranial CT.

Inclusion criteria

1. Patients with clinically suspected stroke
2. Patients 18 years and above.
3. For patients who had more than one CT scan, only the first CT scan was used for analysis.

Exclusion criteria

1. Patients with history of head injury in the past 6 months.
2. Patients on anticoagulant drugs.
3. Patients with TIA.
4. Patients presenting with history of stroke of more than two weeks duration.
5. Patients with confirmed stroke mimics at imaging e.g. extra-axial haemorrhages, tumours and abscess.
6. Patients who refused CT scan or consent.

Methodology

One hundred and thirty consenting patients with clinical features of stroke who were referred from the Emergency or Neurology unit to the Radiology department for cranial CT and fulfilled the inclusion criteria for this study were recruited consecutively. The relevant clinical information were retrieved from the patient or patient relative, CT request form and patient's folder. This included age, sex, clinical diagnosis, duration of symptoms, history of previous systemic arterial hypertension (blood pressure of 160/95 mm Hg or more; previous or current treatment of hypertension), diabetes mellitus, heart failure, obesity, alcohol consumption, previous history of stroke or TIA and cigarette smoking.

Non contrast CT scan of the head was performed on 130 consented participants using Philips brilliance (16 slices) 1622, 2010 CT Machine. Patient was placed supine on the scanner table with head resting on the head support and positioning aided by the external alignment lights. The orbitomeatal baseline was placed parallel to the transverse alignment light and the median sagittal plane perpendicular to the table top and coincident with the sagittal alignment light. The coronal alignment light was then positioned at the mid axillary plane. To ensure skull symmetry, the external auditory meatus (EAM) was equidistant from the skull support and the interpupillary line was parallel to the scan plane. The head was secured in position with the aid of straps. The patient was then moved into the gantry and the table was raised to bring the scan reference point to the level of EAM.

A lateral skull scanogram was obtained, from 5cm below to 12cm above the baseline. Subsequently 5mm thick axial contiguous sections were acquired from the foramen magnum to the superior border of the petrous bone, parallel to the orbitomeatal baseline using the scanogram as a reference image. Further 10mm thick contiguous sections were done from the superior border of the petrous bone to the skull vertex. The exposure factors used were 120 kV and 250 mA. Fifty (50)mls of none ionic contrast medium (350mg/ml) was administered via antecubital vein at 2mls/s using automatic infusion pump and given only when intracranial haemorrhage was ruled out. The images were automatically reformatted into sagittal and coronal sections.

The images obtained were reviewed by the researcher with two other consultant radiologists independently. Discrepancies in interpretation between two observers were resolved by consensus.

Hyperdense lesion (Fig. 1) represents hematoma and hypodense lesion (Fig. 2) represents infarction. Haemorrhages were categorized as intracerebral haemorrhage (ICH), subarachnoid haemorrhage (SAH), and intraventricular haemorrhage (IVH). Lesions were classified based on location as either lobar (frontal, parietal, temporal or occipital), Thalamic-ganglionic hematoma (caudate, putamen and thalamic), brainstem (mid-brain, pons and medulla) and / or cerebellar. The extent, location, vascular territory and other associated features were determined.

Ethical Consideration

Informed written consent was obtained from each patient before enlistment into the study (appendix II). An approval to carry out the study was obtained from the Ethical Committee of the Federal Teaching Hospital Gombe (appendix III). The participants/relatives were enlightened on the entire procedure and were made to know they could withdraw at any stage of the study without any consequences. The data collected were recorded serially and kept with utmost confidentiality. Identification number rather than name was allocated to each patient during the data collection.

STATISTICAL ANALYSIS

The data was analysed using statistical package for the social sciences (SPSS) version 16. The demographic variables of subjects were presented as proportions for categorical variable and mean +/- standard deviation for continuous variables. Proportions of stroke in the various subtypes and vascular territories were presented as percentages. The clinical diagnosis of stroke subtypes were compared with CT diagnosis using kappa statistic and point-biseral correlation analysis was used to correlate risk factors of stroke with specific stroke subtypes. Differences in prevalence of ischaemic and haemorrhagic stroke were tested for statistical significance using chi square test and the level of significance was put at p less than or equal to 0.05 ($p \leq 0.05$).

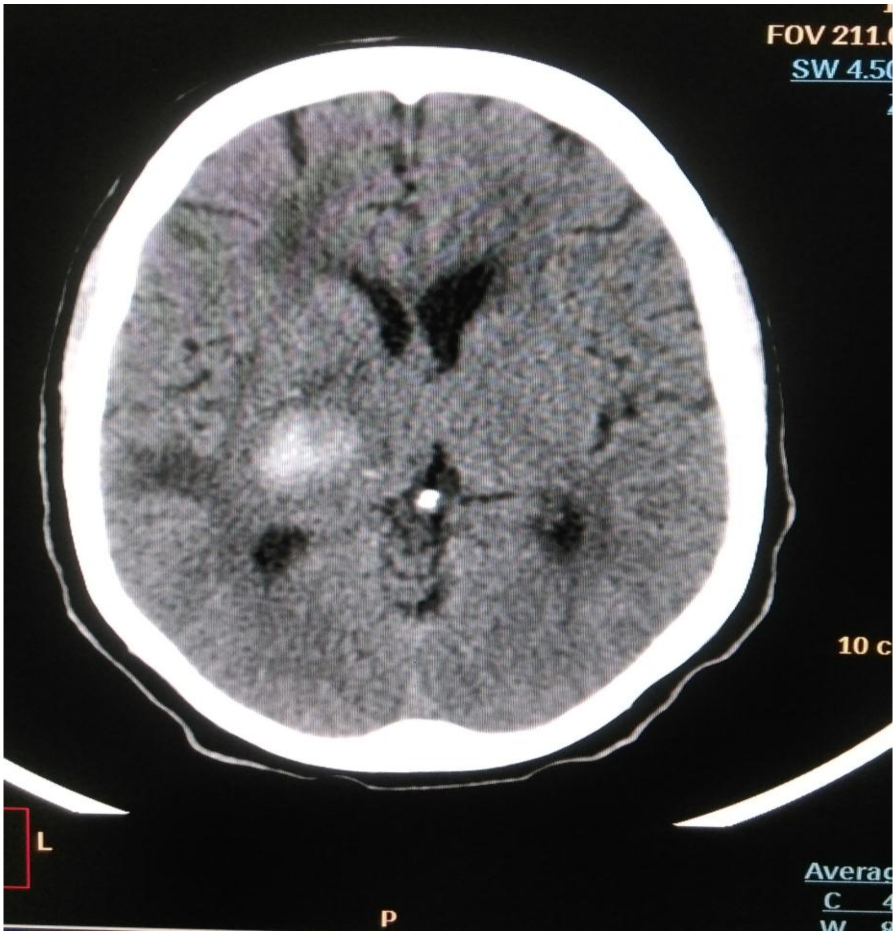

Figure 1: Non contrast cranial CT of the brain showing an oval shaped hyperdensity (hematoma) in the right basal ganglia (putamen) with compression of the adjacent lateral ventricle.

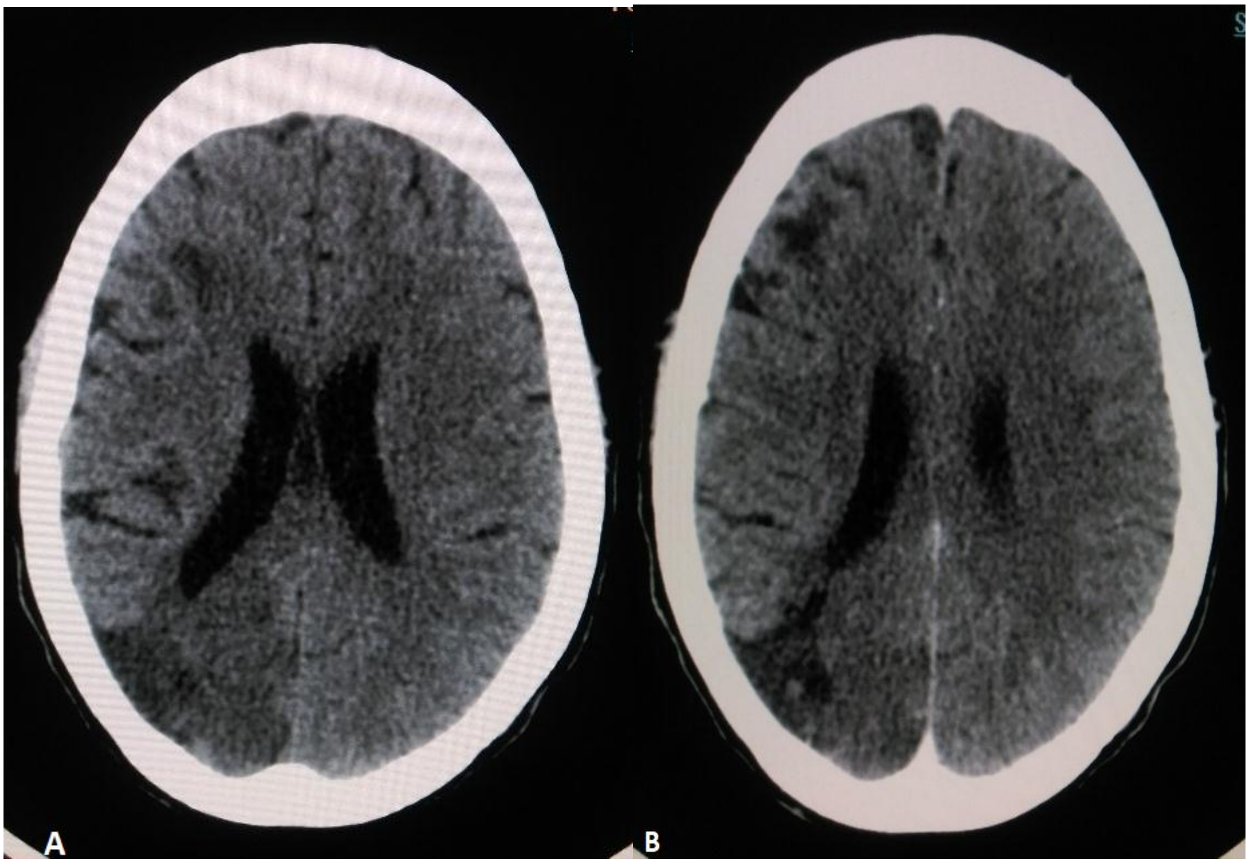

Figure 2: Axial CT brain (A) precontrast and (B) post contrast images showing a nonenhancing wedge shaped hypodensity in the right occipital lobe in keeping with infarction

RESULTS

Demographic characteristic of the study population

A total of 130 patients referred to Radiology department with clinical features of stroke were consecutively selected for this study. 111 had CT scan features of acute stroke, 6 had brain atrophy, 8 had intracranial space occupying lesion and 5 were normal. Thus 111 patients were analysed of which 69 (62.2%) were males and 42 (37.8%) were females (Fig. 3). The age range of the participants was 18 to 90 years with a mean age (± SD) of 57.49 (± 13.47) years. Twenty seven percent of these patients were in the age group of 41-50 years (Fig. 4) making it the highest of frequency while the least number of participants were in the age group of 11-20 years (0.9%). Table I shows the distribution based on age and gender of the patients. The Table shows that patients aged between 41 and 60 were most affected in both male and female patients. It is important to note that between the age of 11 and 40 no case was recorded for the males, however among females 10(9%) cases were recorded.

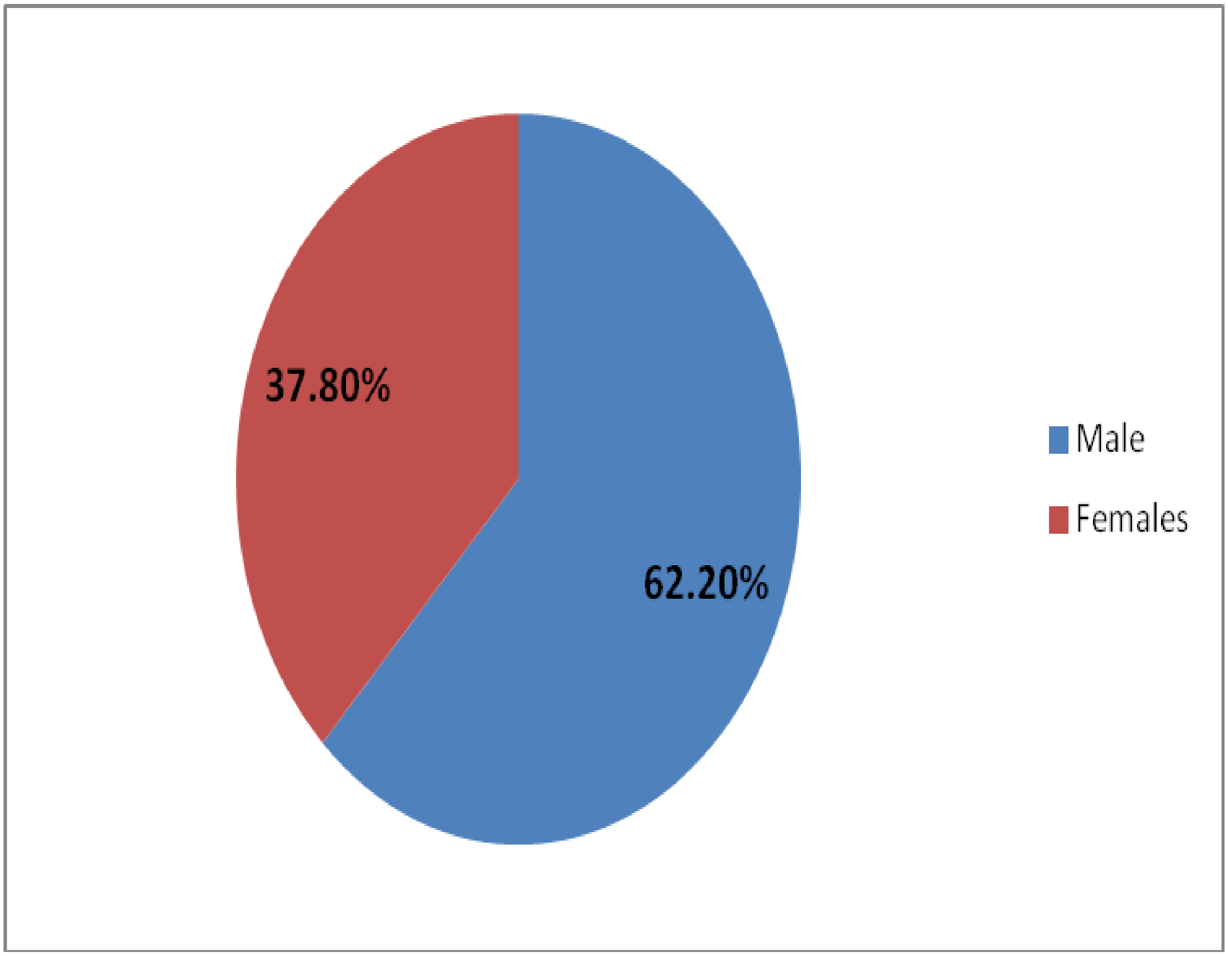

Figure 3. Pie chart showing sex distribution of the study population.

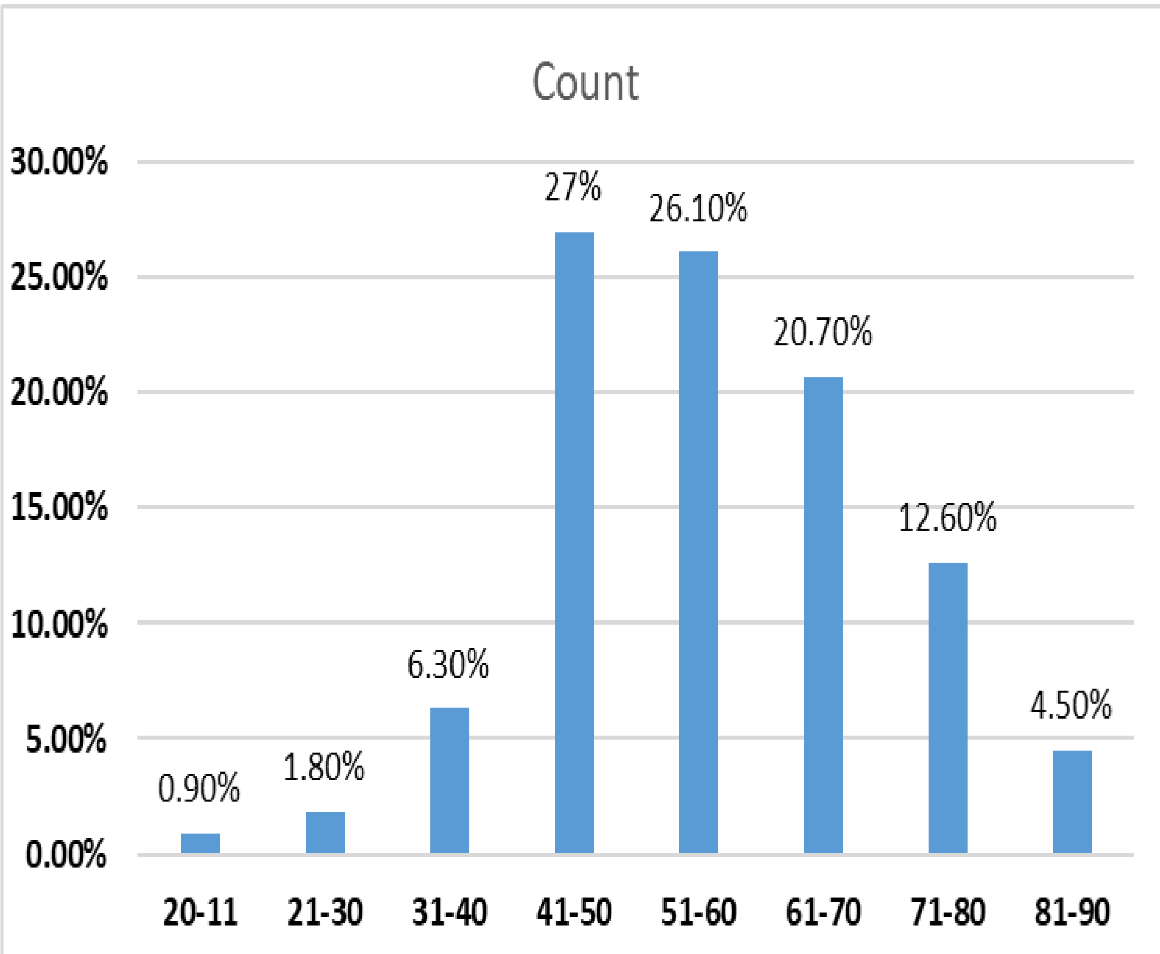

Figure 4. Bar chart showing the various age groups and the frequency of their distribution of the study population.

Table I: Age and gender distribution of the study population with CT features of stroke.

Age group (yrs)	Male	Female	Total
11-20	0(0%)	1(0.9%)	1(0.9%)
21-30	0(0%)	2(1.8%)	2(1.8%)
31-40	0(0%)	7(6.3%)	7(6.3%)
41-50	21(18.9%)	9(8.1%)	30(27.0%)
51-60	20(18.0%)	9(8.1%)	29(26.1%)
61-70	18(16.2%)	5(4.5%)	23(20.7%)
71-80	6(5.4%)	8(7.2%)	14(12.6%)
81-90	4(3.6%)	1(0.9%)	5(4.5%)
Total	**69(62.2%)**	**42(37.8%)**	**111(100%)**

Computed tomographic patterns of stroke of the studied population with stroke

Figure 5 shows the distribution of CT subtypes among the participants. Ninety four (94; 84.7%) patients had ischaemic stroke while 17 patients (15.3%) had haemorrhagic stroke. Both ischaemic and haemorrhagic stroke were commoner in males than females; Ischaemic stroke accounted for 53.2% in males and 31.5% in female while haemorrhagic stroke accounted for 9.0% and 6.3% in males and females respectively.

The lobar location (Table II) was the most common site of Ischaemic stroke (64.9%) with medulla and internal capsule location being the least (1.1% each). Similarly the lobar location was the commonest site (Table III) for Haemorrhagic stroke accounting for 29.4% followed by Basal ganglia location accounting for 23.5% while the least location was subarachnoid (7.1%).

The side of involvement as shown on Table IV, shows 55 (49.4%) occurring on the left side, 39 (35.4%) on the right side and 17 (15.2%) were bilateral. The most common vascular territory affected was MCA seen in 69 patients (62.2%) and in 34 patients (30.6%) multiple vascular territories were involved.

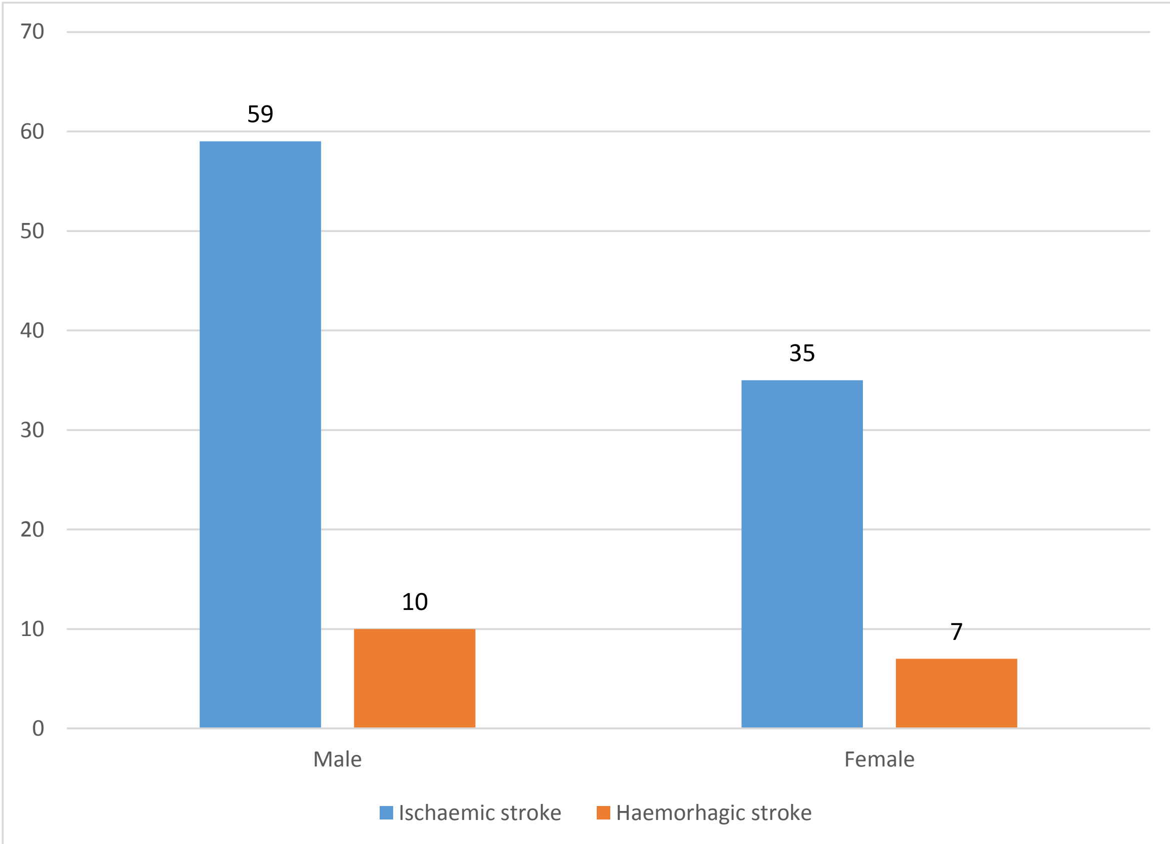

Figure 5: Bar chart showing distribution of CT stroke subtypes according to gender of the patients studied.

Table II: Distribution of Ischaemic stroke based on location

Location	N	Percentage (%)	N=116
Lobar	61	64.9%	
Basal ganglia	6	6.4%	
Internal capsule	1	1.1%	
Thalamus	6	6.6%	
Pons	3	3.2%	
Medulla	1	1.1%	
Cerebellum	3	3.2%	
Multiple location	13	13.8%	
Total	**94**	**100%**	

Table III: Distribution of Haemorrhagic stroke based on location.

Location	N	Percentage (%) N=17
Lobar	5	29.4%
Basal ganglia	4	23.5%
Thalamus	2	11.8%
Internal capsule	1	5.9%
Intra ventricular	2	11.8%
Subarachnoid	1	5.9%
Multiple location	2	11.8%
Total	**17**	**100%**

Table IV: Distribution of stroke based on the Side and Vascular territory involvement.

Location	N	Percentage (%)
Vascular territory		
ACA	1	0.9%%
MCA	69	62.2%
PCA	2	1.8%
VBA	5	4.5%
Multiple	34	30.6%
Total	**111**	**100%**
Side		
Left	55	49.4%
Right	39	35.4%
Both side	17	15.2%
Total	**111**	**100%**

Comparison between clinical diagnosis of stroke subtypes and CT subtypes

Comparison between clinical diagnosis and CT diagnosis of stroke subtypes was made using kappa statistic as shown in Table V. The kappa value was 0.289 signifying poor agreement between clinical diagnosis and CT diagnosis of stroke subtypes p value < 0.002. The sensitivity and specificity of clinical diagnosis of ischaemic stroke were 91.5% and 42.9% respectively whereas the sensitivity and specificity of clinical diagnosis of haemorrhagic stroke were 35.3% and 88.7% respectively. The clinical diagnosis has a positive predictive accuracy of 88.7% for ischaemic stroke and 35.3% for haemorrhagic stroke.

Table V: Diagnostic comparison of stroke by CT scan and clinical diagnosis

Clinical Diagnosis	CT Diagnosis		Kappa = 0.289 p = 0.002			
	Ischaemic stroke	**Haemorrhagic stroke**	**Total**	**Sensitivity**	**Specificity**	**PPA**
Ischaemic stroke	86	11	97	91.5%	42.9%	88.7%
Haemorrhagic stroke	8	6	14	35.3%	88.7%	35.3%
Total	94	17	111			

PPA= positive predictive accuracy

Correlation of CT stroke subtypes with risk factors

Age and hypertension as risk factors were associated in all participants with haemorrhagic stroke (17; 100%) while ischaemic stroke was associated with age and hypertension as risk factors in 93.6% and 95.7% of participants respectively. All cases with DM, cardiac diseases and obesity as risk factors were associated with ischaemic stroke (Table VI). Correlation between ischaemic stroke subtype with risk factors was determined using point-biseral correlation. This showed that age and hypertension were associated with ischaemic stroke with the risk factors demonstrating moderate ($r_{pb} = 0.38$,) and strong ($r_{pb} = 0.75$), positive correlation respectively, however only age was found to be statistically significant, $p = 0.000$ (Table VII).

Table VI: Frequencies of risk factors in ischaemic and haemorrhagic stroke

	Ischaemic stroke		Haemorrhagic stroke	
Risk Factors	**N (94)**	**percentage(%)**	**N (17)**	**percentage (%)**
Age	**88**	**93.6%**	**17**	**100%**
Sex(male gender)	**63**	**67%**	**12**	**70.6%**
Hypertension	**90**	**95.7**	**17**	**100%**
Diabetes mellitus	**18**	**19.1%**	**0**	**0%**
Cardiac diseases	**6**	**6.4%**	**0**	**0%**
Obesity	**3**	**3.2%**	**0**	**0%**
Repeated stroke	**3**	**3.2%**	**4**	**23.5%**

Table VII: Correlation of ischaemic stroke subtype with risk factors

Risk Factors	Pearson Correlation (r)	p-value
Age	0.38	0.00
Sex(male gender)	0.19	0.03
Hypertension	0.75	0.39
Diabetics mellitus	0.17	0.06
Cardiac diseases	0.10	0.82
Obesity	0.04	0.34
Repeated stroke	0.04	0.36

DISCUSSION

This study shows that there is a male preponderance over female with regards to the incidence of stroke, where 69 (62%) of the population studied were males and 42 (37.8%) were females giving a male to female ration of 1.6: 1. This finding is similar to that of Luntsi *et al*[54] who reported 1.7: 1 male to female ratio in the North-East Nigeria. This higher male preponderance was also reported in other studies; Bwala[57] reported a 2.5: 1 male to female ratio in Maiduguri North-Eastern Nigeria and Eze *et al*[11] reported 4:1 male to female ratio in South-Eastern Nigeria.

The increased incidence of stroke in males compared to females might be due to increase risk factors of stroke in males such as HTN, DM, smoking and excess alcohol consumption. Moreso the male gender is a non-modifiable risk factor for stroke.[71]

This study shows that the highest incidence of stroke was among persons between 41 – 60 years age group (53%). This is in contrast with most of the previous studies. Ukoha *et al*[56] for example reported highest incidence of stroke among 60 – 69 age years group. Chiewvit et al[63] also reported high incidence of haemorrhagic stroke at 5^{th} – 6^{th} decade in their study. The early presentation of stroke noted in this study might suggest poor management of the risk factors of stroke from poor compliance of patients to drugs and follow – up regime. The high poverty index and illiteracy rate in the North-East compared to the other geopolitical zones may also contribute for this poor compliance.

About 84.7% of the studied subjects had ischaemic stroke whereas 15.3% had haemorrhagic stroke. These findings are in conformity with the global trend of incidence of stroke subtypes. Studies conducted by Holmes *et al*[1] and Robbins *et al*[72] reported preponderance of ischaemic stroke accounting for 80% in both studies and haemorrhagic stroke accounting for 15% as reported by Robbins et al.[72] Similarly Ikpeme *et al*[60] in their study conducted in Nigeria reported an incidence of 81% for ischemic and 19% for haemorrhagic stroke. Similarly Watila *et al*[66] in their study conducted in Maiduguri, North-Eastern Nigeria also recorded high incidence of ischaemic stroke (62%), while haemorrhagic stroke accounted for 32% and SAH was the least accounting for just 1.2%. The high incidence of ischaemic stroke might be explained by the multiple risk factors associated with ischaemic stroke, whereas the single most important risk factor for haemorrhagic stroke is hypertension.

On the contrary Obiako *et al*[53] studied adult patients who presented to the medical emergency unit of University College Hospital (U.C.H), Ibadan in coma from acute stroke. They highlighted that in this group of stroke patients, intracerebral hemorrhage was more frequent (78.8%) while large cerebral infarction accounted for 21.2%. The higher incidence of haemorrhgic stroke in this study may be explained by the design of the study population; biased to acute stroke presenting with coma. It is a well-known fact that haemorrhagic stroke presents with loss of consciousness more than ischaemic stroke due to the associated mass effect exerted on the brain parenchyma by the haemorrhage. Moreso haemorrhagic stroke is usually a sudden episode against a more insidious ischaemic stroke.

In this study lobar location is the most common site for Ischaemic stroke (64.9%) with medulla location being the least (1.1%) site of occurrence. Similarly the lobar location is also the commonest site for Haemorrhagic stroke accounting for 28.4% followed by Basal ganglia location accounting for 23.5% while the least location was the subarachnoid space (SAH). If the thalamic and basal ganglia location for haemorrhgic stroke were combined as thalamo-ganglionic location as described by many authors, then the thalamo-ganglionic location would be the commonest location (35.3%) for haemorrhagic stroke in this study. This is in agreement with the findings of Chiewvit *et a*[63] where they found that the commonest location of haemorrhagic stroke was thalamic-ganglionic (53/131 cases, 40.5%), followed by lobar location (5/131 cases, 3.8%), brainstem (8/131 cases, 6.1%) and cerebellum (5/131 cases, 3.8%).

Alkali *et al*[67], in a review of 272 patients in Abuja, Nigeria documented that, lobar location was most common site (35.1%) for haemorrhagic stroke, followed by the basal ganglia (28.7%), thalami (18.1%), pons (9.6%), cerebellum (5.3%) and the midbrain was the least (2.1%). These findings are in keeping with the result of this study.

The most common side of occurrence of stroke in this current studied population is the left side 55 (49.4%), with 39 (35.4%) on the right side and 17 (15.2%) bilateral. This is in conformity with the findings of Ikpeme *et al*[60] who reported 53% on the left side, 40% on the right side and 6.6% bilateral. This might be explained by the fact that majority of people are right handed thus the left half of the brain is the most active and multi-tasking hemisphere hence more prone to stroke.

This study also observed that the most common vascular territory involved is MCA territory seen in 69 patients (62.2%) while the least is the ACA territory (0.9%). This is similar to the report of a study conducted by Chhetri *et a*[51] who reported a 75% involvement of the MCA and 10% of ACA. The preponderant involvement of the MCA is probably because the MCA is the largest cerebral vessel and the one in direct continuity with the internal carotid artery thus prone to direct transmission of thrombus.

The advancement in the management of acute stroke stipulates differentiating ischaemic from haemorrhagic stroke as the first step in the management of acute stroke. CT scan is the gold standard imaging modality for achieving this.

The study further shows that clinical diagnosis of stroke subtypes is by far less accurate in comparison to CT diagnosis. The sensitivity and specificity of clinical diagnosis for ischaemic stroke when compared with CT diagnosis are 91.5% and 42.9% respectively while the sensitivity and specificity for haemorrhagic stroke are 35.3% and 88.7% respectively. The positive predictive accuracy for clinical diagnosis of both subtypes further validate the non-reliability of clinical diagnosis of stroke. This finding is in conformity with a study conducted by Badam *et al*.[73] They reported from their findings that, clinical diagnosis is not accurate in differentiating ischaemic from haemorrhagic stroke.

Ogun *et al*[70] also highlighted the need for cranial CT in patients with stroke, as the clinical diagnosis demonstrated only 50% accuracy in diagnosing haemorrhagic stroke and 58% in diagnosing ischaemic stroke when compared with the CT findings of the same patients. In a similarly prospective study conducted by Jehangir *et al*[70], they compared clinical diagnosis with CT findings in ascertaining stroke subtypes, and they found out that of 25 clinically suspected haemorrhagic stroke only 13 had haemorrhage on CT scan showing 52% accuracy of clinical diagnosis, while the rest 12 (48%) had infarction. In the same study out of the 43 clinically suspected ischaemic stroke only 25 proved to have infarction on CT scan reflecting a clinical accuracy of 58.6%.

The clinical differentiation between haemorrhagic and ischemic lesions has proved problematic, because small hematomas may cause symptoms and signs that are identical to those caused by infarcts while large infarcts might present with features identical to hematoma.

In this study age and hypertension as risk factors were found exist in all subjects with haemorrhagic stroke (100%) while ischaemic stroke was associated with age and hypertension in

93.6% and 95.7% respectively. All cases with DM, cardiac diseases and obesity as risk factors were associated with ischaemic stroke only. This finding is in agreement with many studies.[53,63,66] Similarly Ukoha *et al*[56] in their study of stroke risk factors revealed systemic hypertension as the commonest risk factor associated with both ischaemic and haemorrhagic stroke.

In another study conducted by Watila *et al*[66], the most frequent risk factors found were hypertension 87%, past history of stroke 11.5%, diabetes mellitus 10.1%, alcohol consumption 8.8%, smoking 6.8% and heart failure 2.4% while 19.7% had more than one risk factor.

Similarly Abubakar *et* al[67] in their study indicated that, systemic hypertension as a risk factor was documented in 51% of ischaemic stroke, and was found to be higher in haemorrhagic stroke 62%. Diabetes mellitus was less frequent in haemorrhagic stroke (8%). They also found that almost all patients with previous history of TIA had ischaemic stroke and constituted 13% of patients with stroke.

Chiewvit *et al*[63] found 75% of all stroke patients with associated systemic hypertension which is in agreement with the findings of this study. However, the remaining 25% of their studied patients had no associated risk factors which is in contradicted to our findings where all the patients reviewed had one or more risk factors.

Limitations of the study

1. Inter-observer variability which was however resolved through consensus in those cases.

2. This was a hospital based study which is not a true representation of the study population.

CONCLUSION

This study has highlighted the CT pattern of stroke in Gombe North-Eastern Nigeria. The value of computed tomography in making accurate diagnosis of stroke subtypes rather than relying solely on clinical diagnosis was emphasised. The MCA territory is the commonest vascular territory involved in stroke. Hypertension and age are common risk factors identified for both ischaemic and haemorrhagic stroke.

Recommendations

1. A similar study with larger sample size that will increase the validity of this study is recommended.
2. A further study that will correlate clinical scoring and CT diagnosis is suggested.
3. Multicentre base study which will further validate this study is recommended.

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APPENDIX I

BIODATA STROKE CT PATTERN

S/No	AGE	SEX	CDX	CT SUBTYPE	STROKE PATTERN			
					SIDE(LT/RT)	LOCATION	VT	RF

KEY; VT= vascular territory, RF= risk factor/s CDx= clinical diagnosis

APPENDIX II

INFORMED CONSENT FORM

My name is Dr. Yunusa Dahiru Mohammed, a Senior Registrar with the Department of Radiology, Federal Teaching Hospital, Gombe (FTHG). I am conducting a reaearch on the C**omputed tomographic pattern of stroke among adults in Federal Teaching Hospital Gombe, North Eastern Nigeria** and would like you to participate in the study.

The study will involve asking you/ your relative some questions about your health. This research will establish computed tomographic pattern of stroke that may define the subtype, exact location and the vessel involved. These could help in monitoring and treatment of stroke patients. Your participation in the study is voluntary, and as such you are free to decline consent and you will not suffer any consequence if you decide not to participate or decide to opt out at any stage of the study. For further enquiries about the study please contact:

Dr. Yunusa Dahiru Muhammed

Department of Radiology, FTH Gombe.

I have understood the study as directly explained to me and I am willing to participate.

Investigator’s Sign……………………………

Participant’s Sign/Thumb print………………

APPENDIX III

FEDERAL TEACHING HOSPITAL, GOMBE

Ashaka Road, Gombe
P.M.B. 0037

Tel: 072-223410,
223064
Fax:072-223909

Our Ref: NHREC/25/10/2013

Date: 4th January, 2016

Dr Yunusa Dahiru Mohammed
Department of Radiolog y,
Federal Teaching Hospital,
Gombe.

Sir,

Ethical Clearance

I am directed to inform you that your application and proposal Titled: **COMPUTED TOMOGRAPHY PATTERN OF STROKE IN ADULT PATIENTS AT THE FEDERAL TEACHING HOSPITAL GOMBE, NORTH-EASTERN NIGERIA'.** Submitted to the Hospital Research and Ethics Committee, have been duely reviewed and approved.

The committee will like to know the progress of your research work periodically please.

On behalf of the committee, I wish you a successful execution.

Thank you,

B.A. Sambo Mrs. (Jp, CLN, ADL)
Secretary R&EC.

Chief Medical Director: Dr. Abubakar Sa'idu MBBS, FMCP